**Al Mansoura University**

**Faculty of Engineering**

**Electronics and Communications Dept.**

**2nd Year Students**

**Logic Circuit 2**

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**Chapter 1: Latches**

**Lecture No. 4**

## 1.12-One Shots.

- ✓ The one-shot is a monostable multivibrator, a device with only one stable state.
- ✓ A one-shot is normally in its stable state and will change to its unstable state only when triggered.
- ✓ Once it is triggered, the one-shot remains in its unstable state for a predetermined length of time and then automatically returns to its stable state.
- ✓ The time that the device stays in its unstable state determines the pulse width of its output.

✓ Figure 1.24 shows a basic one-shot (monostable multivibrator) that is composed of a logic gate and an inverter.

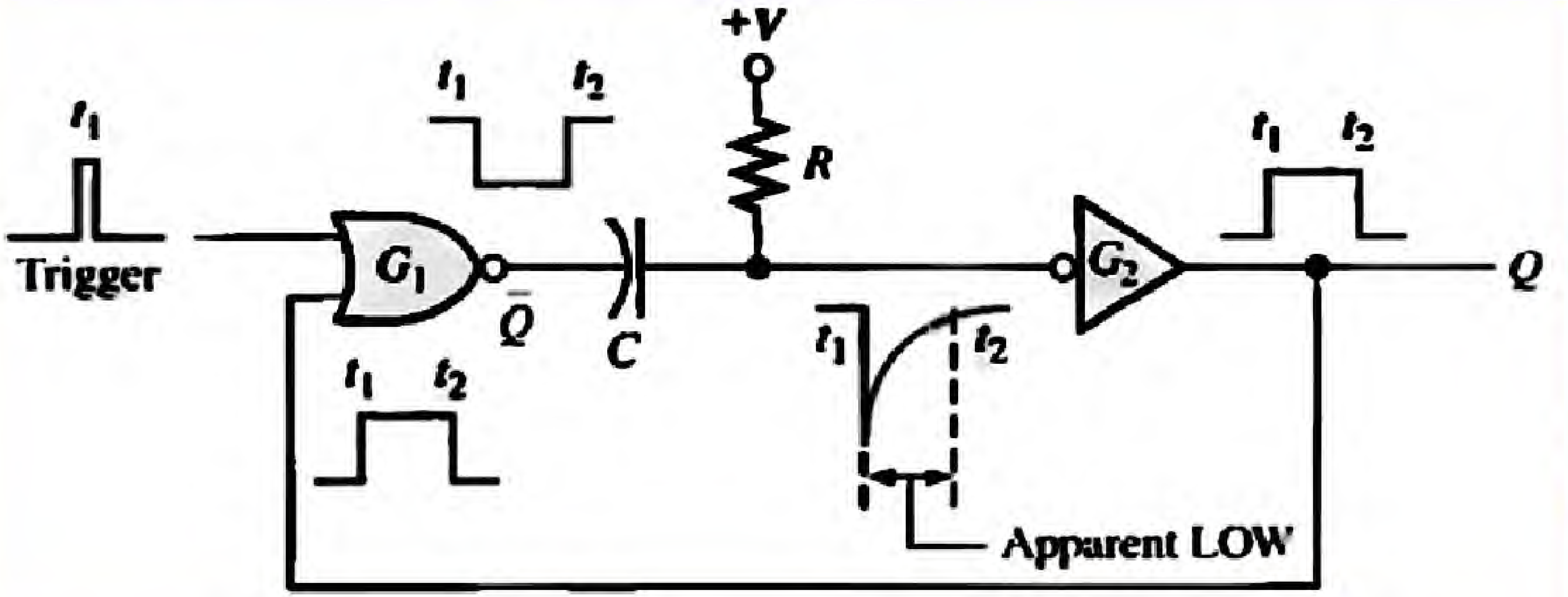
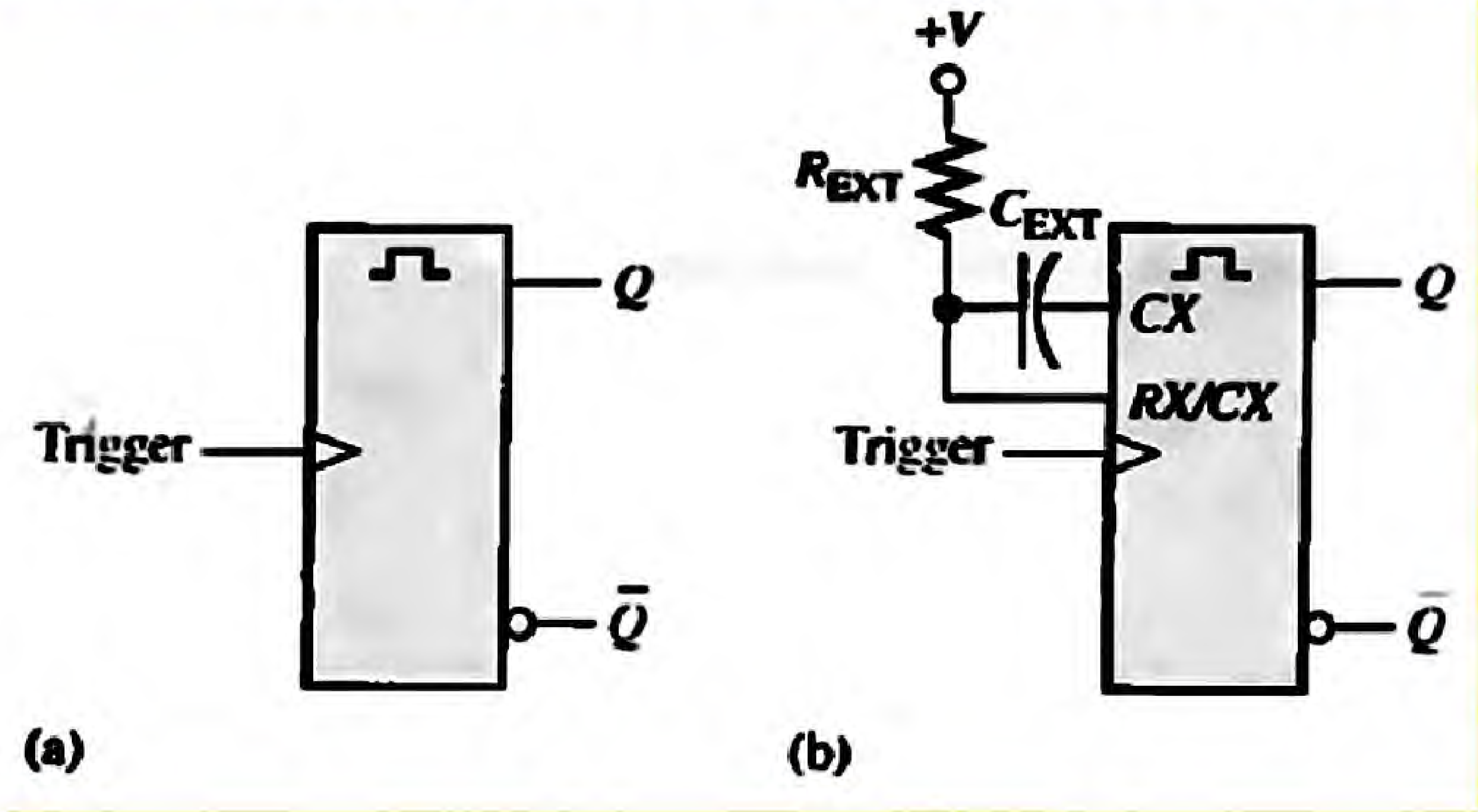



Figure (1.24) A simple one-shot circuit.

- ✓ **When a pulse is applied to the trigger input, the output of gate $G_1$ goes LOW. This HIGH-to-LOW transition is coupled through the capacitor to the input of inverter $G_2$.**
- ✓ **The apparent LOW on $G_2$ makes its output go HIGH.**
- ✓ **This HIGH is connected back into $G_1$ keeping its output LOW.**
- ✓ **Up to this point the trigger pulse has caused the output of the one-shot, Q, to go HIGH.**

- ✓ The capacitor immediately begins to charge through R toward the high voltage level. The rate at which it charges is determined by the RC time constant.
- ✓ When the capacitor charges to a certain level, which appears as a HIGH to $G_2$ the output goes back LOW.
- ✓ To summarize, the output of inverter $G_2$ goes HIGH in response to the trigger input. It remains HIGH for a time set by the RC time constant. At the end of this time, it goes LOW.

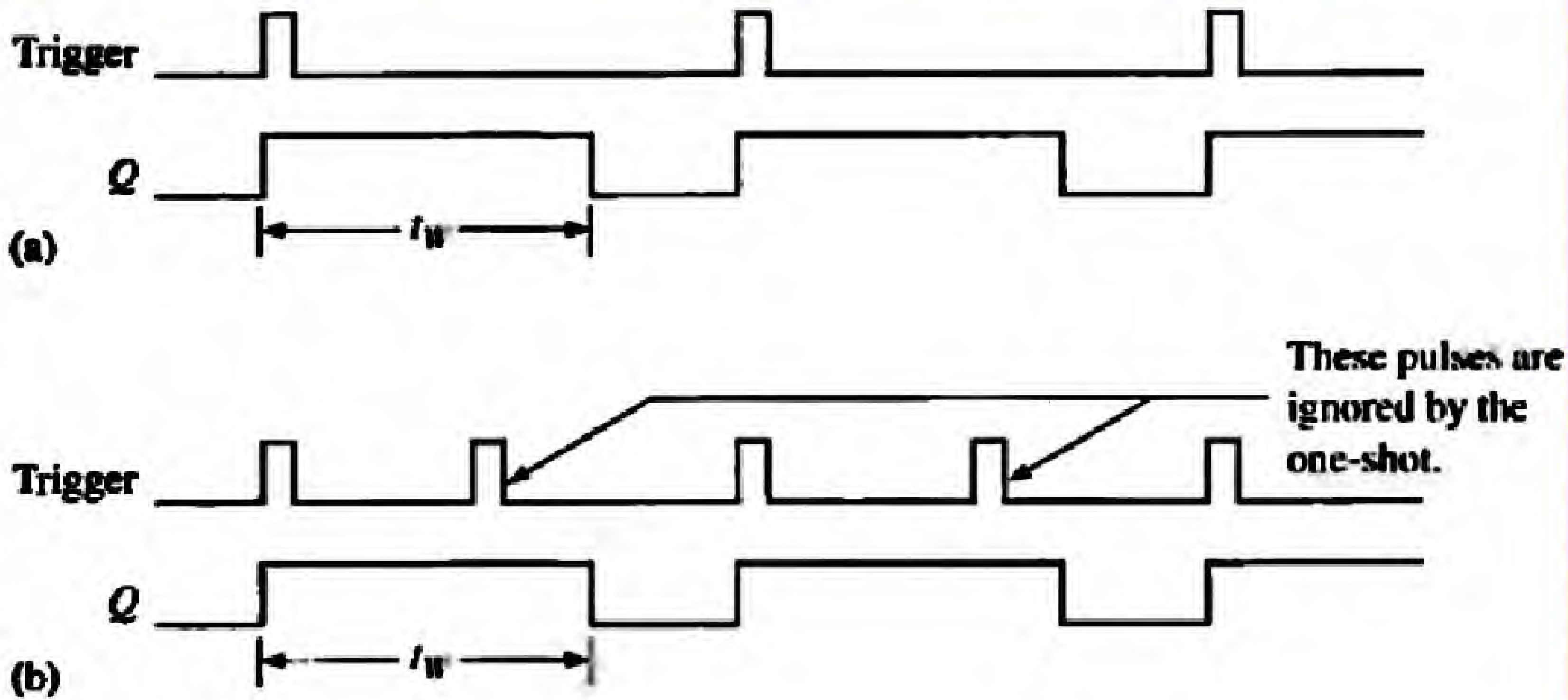
✓ A single narrow trigger pulse produces a single output pulse whose time duration is controlled by the RC time constant. This operation is illustrated in Figure 1.24.



- A typical one-shot logic symbol is shown in Figure 1.25(a), and the same symbol with an external R and C is shown in Figure 1.25(b).
- The two basic types of IC one-shots are nonretriggerable and retriggerable.

- A nonretriggerable one-shot will not respond to any additional trigger pulses from the time it is triggered into its unstable state until it returns to its stable state.
- In other words, it will ignore any trigger pulses occurring before it times out. The time that the one-shot remains in its unstable state is the pulse width of the output.

✓ Figure 1.26 shows the nonretriggerable one-shot being triggered at intervals greater than its pulse width and at intervals less than the pulse width. Notice that in the second case, the additional pulses are ignored.



- ✓ A retriggerable one-shot can be triggered before it times out. The result of retriggering is an extension of the pulse width as illustrated in Figure 1.27.

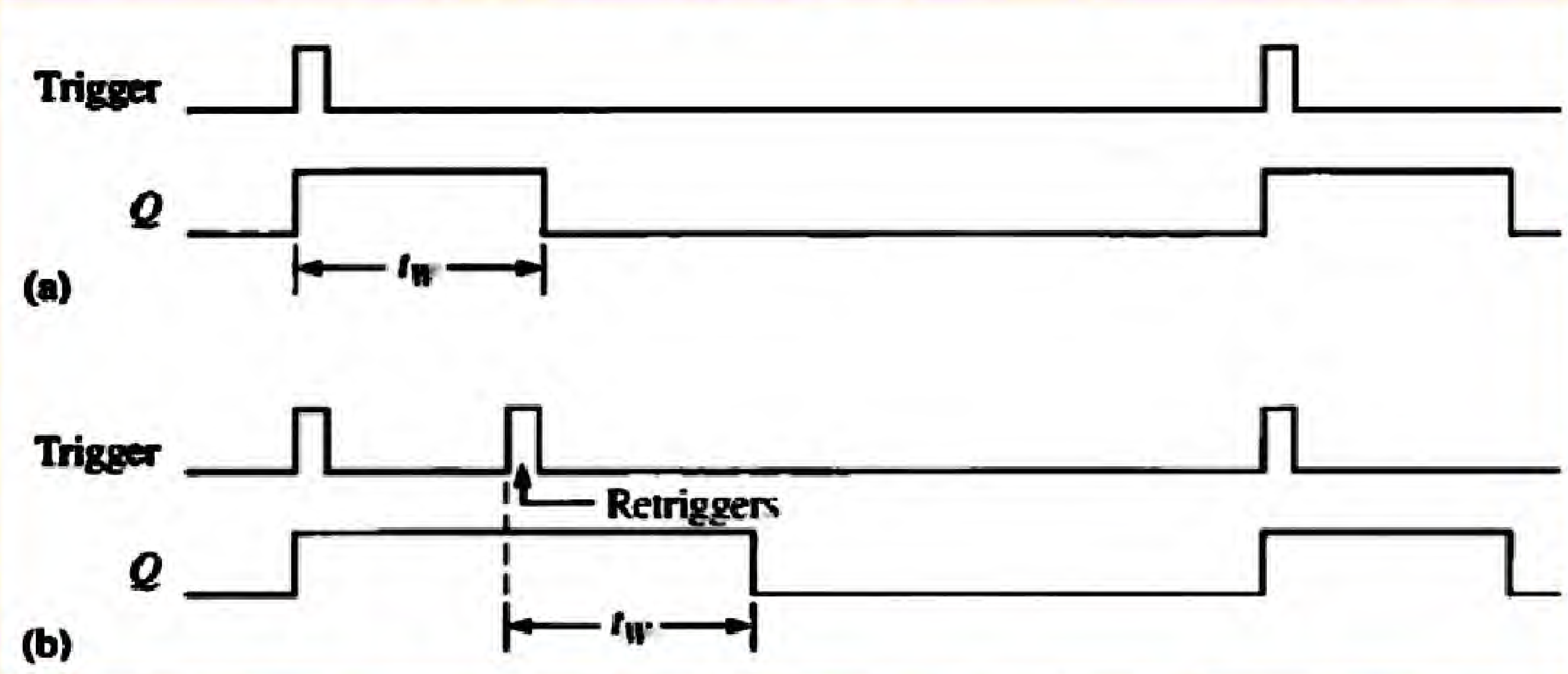
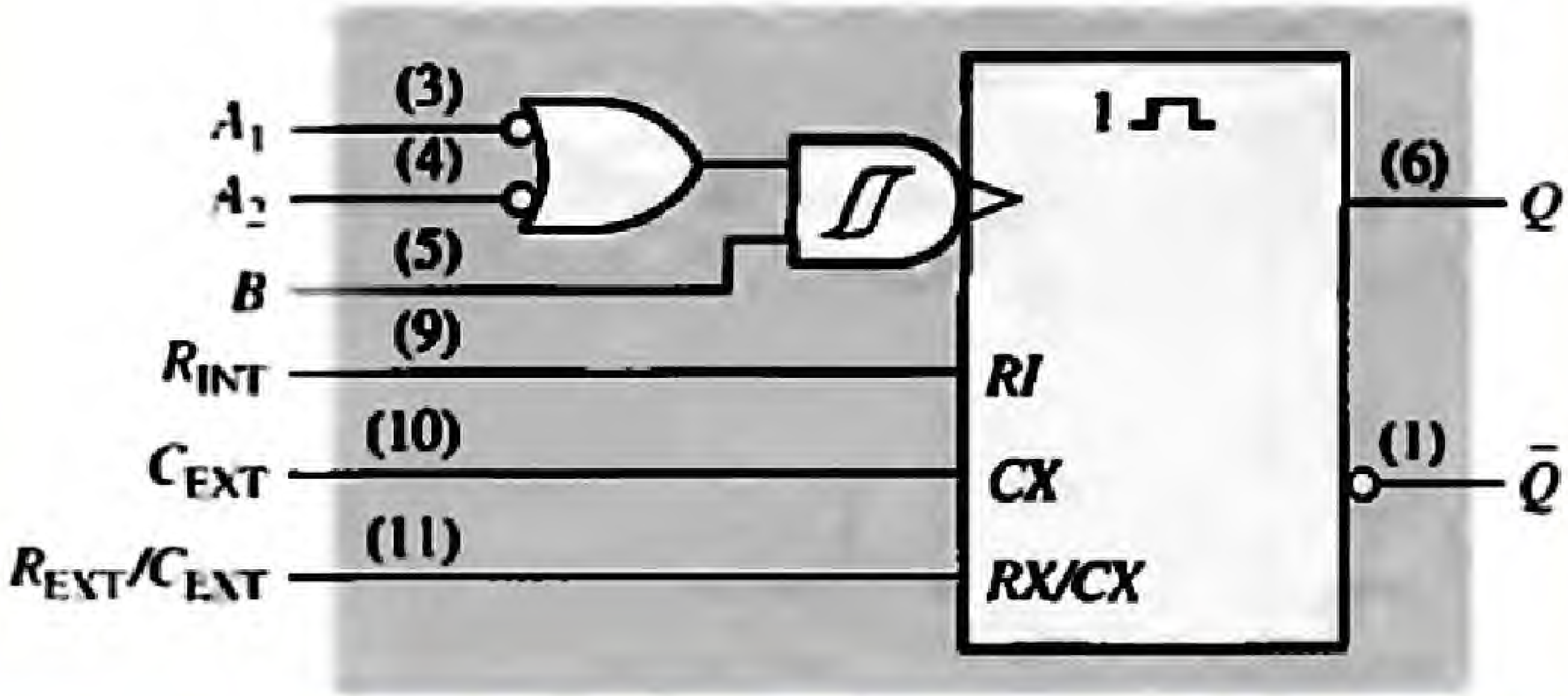


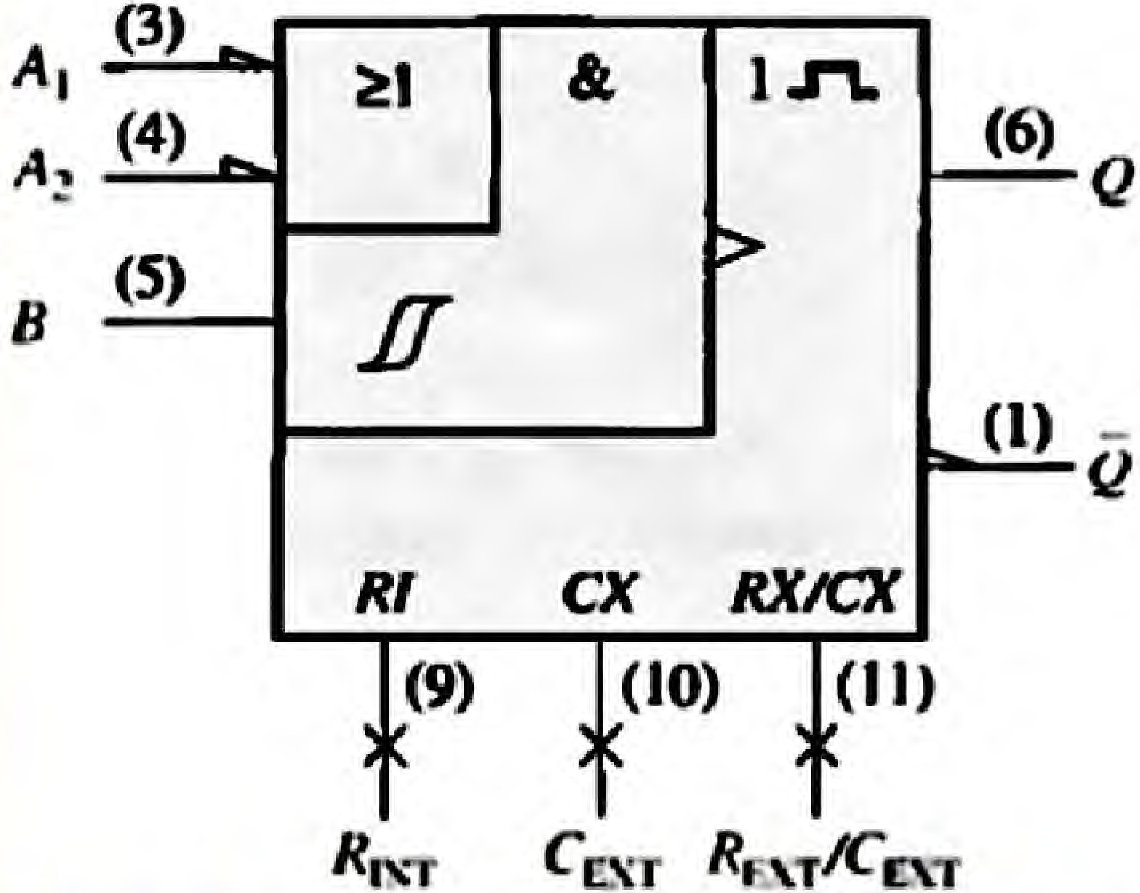

Figure (1.27) Retriggerable one-shot action.

## 1.12.1-The 74121 Nonretriggerable One Shot.

- ✓ The 74121 (TTL) is an example of a nonretriggerable IC one-shot. It has provisions for external R and C, as shown in Figure (1.28). The inputs labeled $A_1$ $A_2$, and B are gated trigger inputs. The $R_{INT}$ input connects to a $2k\Omega$ internal timing resistor.




**(a) Traditional logic symbol**




(b) ANSI/IEEE logic symbol (X = nonlogic connection).

"1⎍" is the qualifying symbol for a nonretriggerable one-shot.

## 1.12.2-Setting the Pulse Width.

- ✓ A typical pulse width of about 30 ns is produced when no external timing components are used and the internal timing resistor ($R_{INT}$) is connected to $V_{CC}$, as shown in Figure 1.29(a).

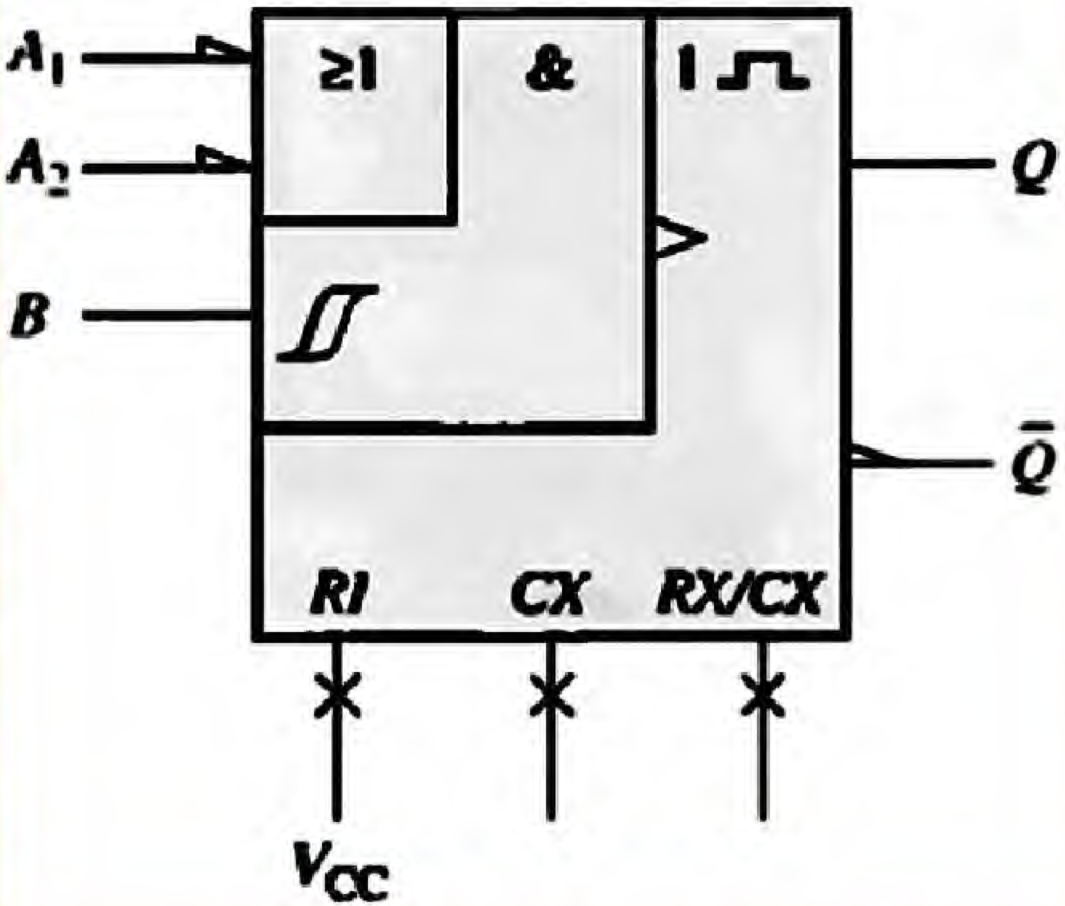



**Figure (1.29)-(a) No external components $R_{INT}$ to $V_{CC}$, $t_W$ = 30ns**

✓ The pulse width can be set anywhere between about 30 ns and 28 s by the use of external components. Figure (1.29)(b) shows the configuration using the internal resistor (2 kΩ) and an external capacitor.

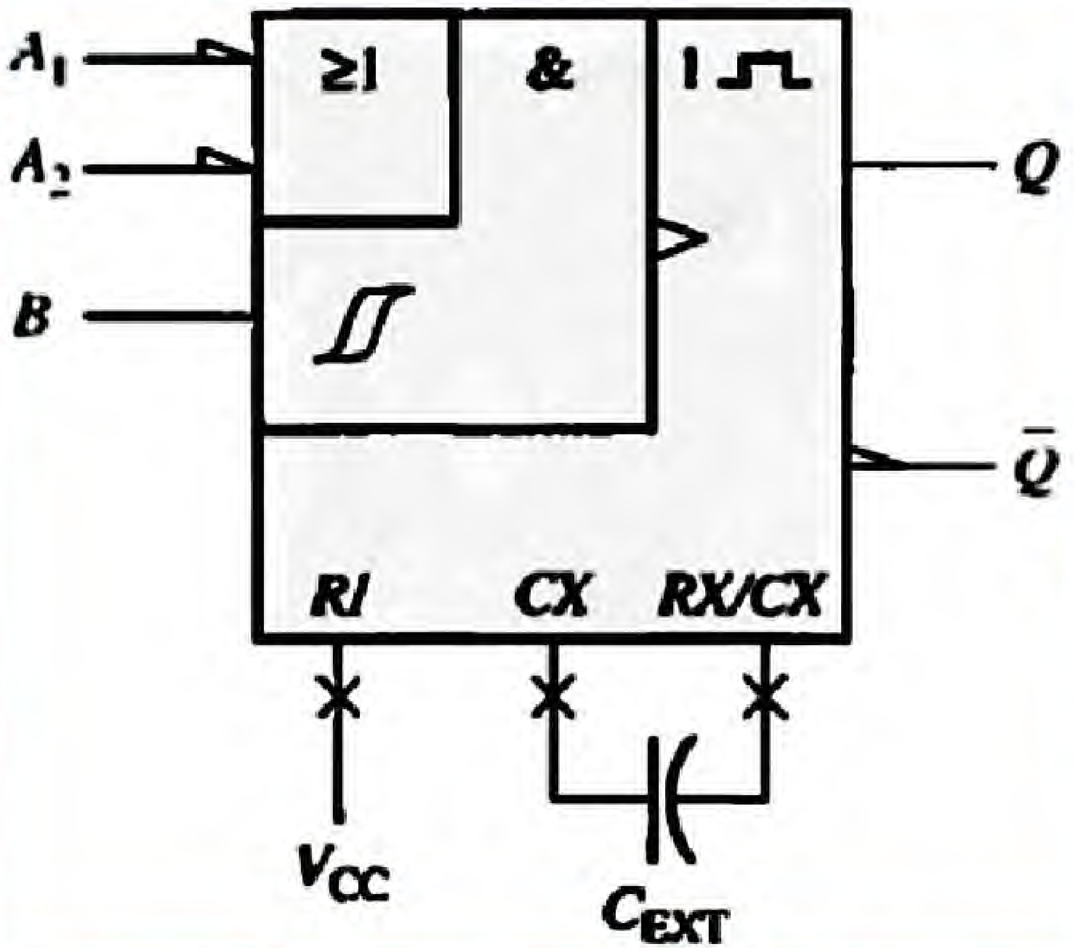



**Figure** **(1.29)(b)** **$R_{INT}$ and $C_{EXT}$,** $t_W = 0.7 \times 2k\Omega \times C_{EXT}$

- ✓ **Figure (1.29)(c) shows the configuration using an external resistor and an external capacitor.**
- ✓ **The output pulse width is set by the values of the resistor ($R_{INT}$ = 2 kΩ, and $R_{EXT}$ is selected) and the capacitor according to the following formula:**

$$t_W = 0.7 \times R \times C_{EXT}$$

- ✓ **Where R is either $R_{INT}$ or $R_{EXT}$. When R is in kilohms (kΩ) and $C_{EXT}$ is in picofarads (pF), the output pulse width $t_W$ is in nanoseconds (ns).**

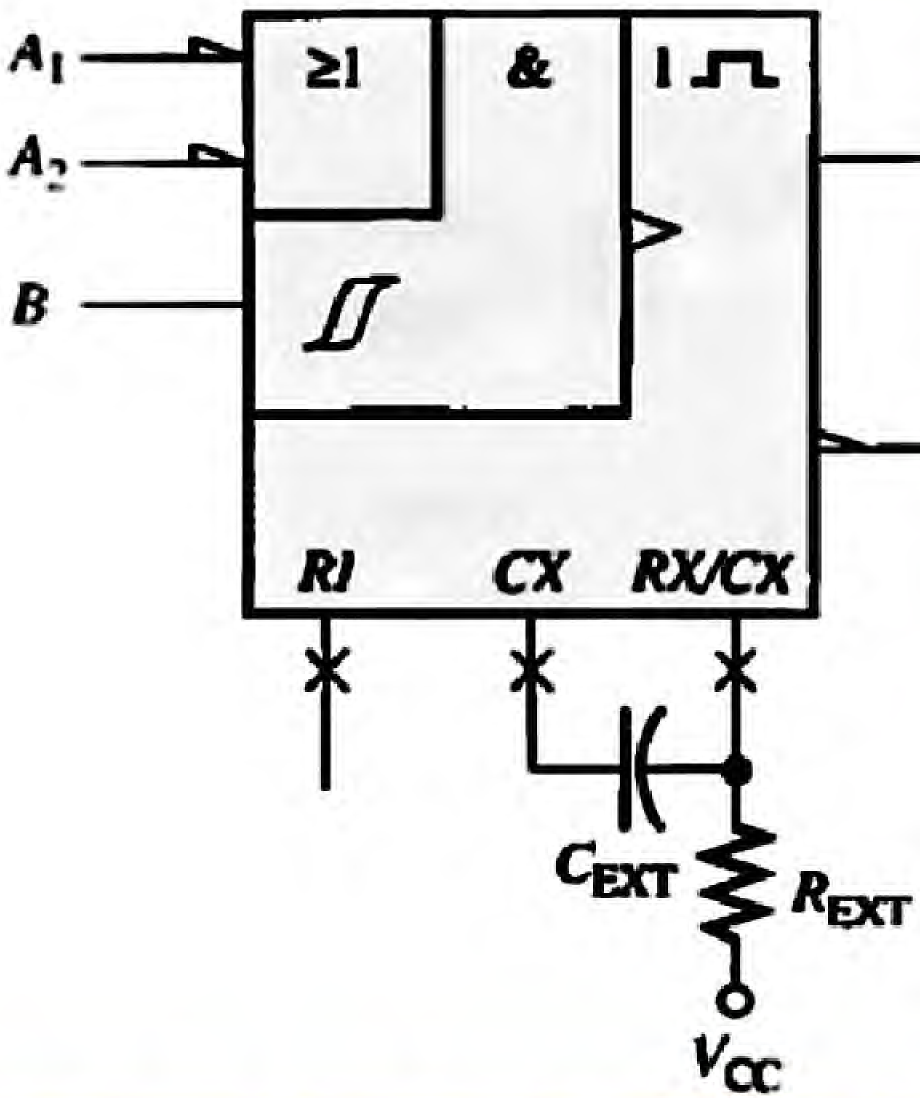



**Figure** (1.29)(c) $R_{EXT}$ and $C_{EXT}$ $t_W = 0.7\ R_{EXT}\ C_{EXT}$

## 1.12.3-The Schmitt-Trigger Symbol

- The symbol  indicates a Schmitt-trigger input. This allows reliable triggering to occur even when the input is changing as slowly as 1 volt/second.

## 1.12.4- The 74LS122 Reteriggerable One Shot.

- The 74LSl22 is an example of a retriggerable IC one-shot with a clear input.
- It also has provisions for external R and C. as shown in Figure (1.30). The inputs labeled $A_1$ $A_2$, $B_1$ and $B_2$ are the

gated trigger inputs.

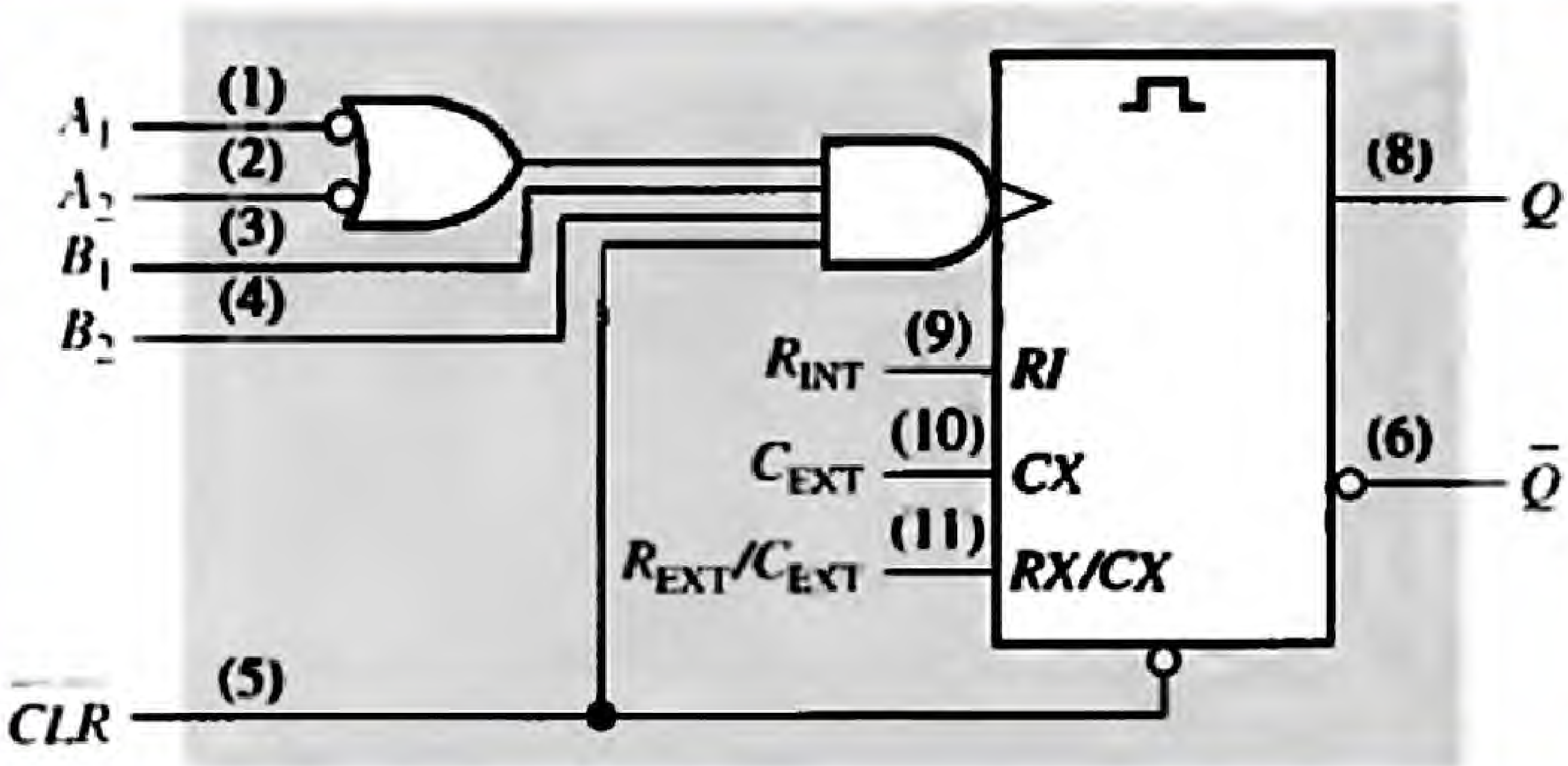



Figure (1.30)(a) Traditional logic symbol

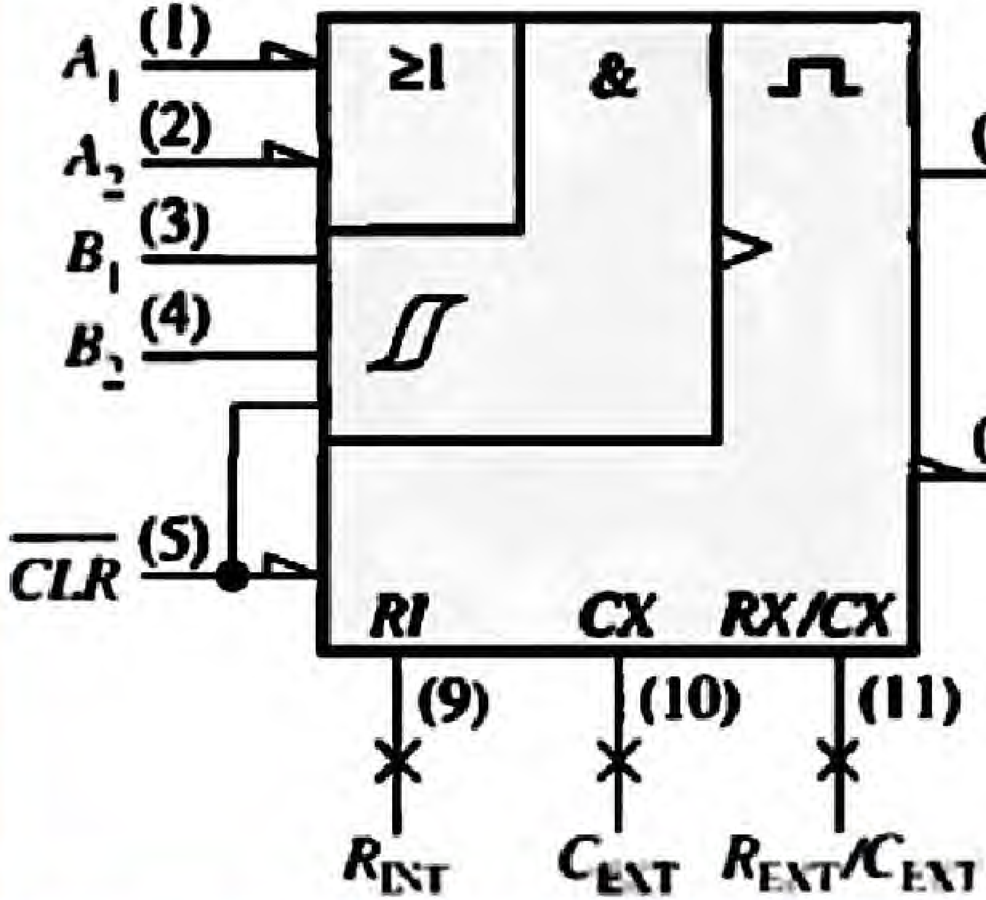



**Figure (1.30)(b) ANSI/IEEE logic symbol (X = nonlogic connection).**  **is the qualifying symbol for a retriggerable**

- ✓ A minimum pulse width of approximately 45 ns is obtained with no external components. Wider pulse widths are achieved by using external components.
- ✓ A general formula for calculating the values of these components for a specified pulse width ($t_W$) is:

$$t_W = 0.32\, R\, C_{EXT}\left(1 + \frac{0.7}{R}\right)$$

- ✓ Where 0.32 is a constant determined by the particular type of one-shot, R is in kΩ and is either the internal or the external resistor, $C_{EXT}$ is in pF, and $t_W$ is in ns.

- ✓ The internal resistance is 10 kΩ and can be used instead of an external resistor.

Example 1.11 A certain application requires a one-shot with a pulse width of approximately 100 ms. Using a 74121, show the connections and the component values.

Solution:

- ✓ Arbitrarily select $R_{EXT}$ = 39 kΩ and calculate the necessary capacitance.

$$t_W = 0.7 \times R_{EXT} \times C_{EXT}$$

$$C_{EXT} = \frac{t_W}{0.7 \times R_{EXT}}$$

$$C_{EXT} = \frac{100 \times 10^{-3}}{0.7 \times 39 \times 10^{3}} = 3.66\ \mu F$$

- ✓ A standard 3.3 μF capacitor will give an output pulse width of 91 ms.
- ✓ The proper connections are shown in Figure (1.31).

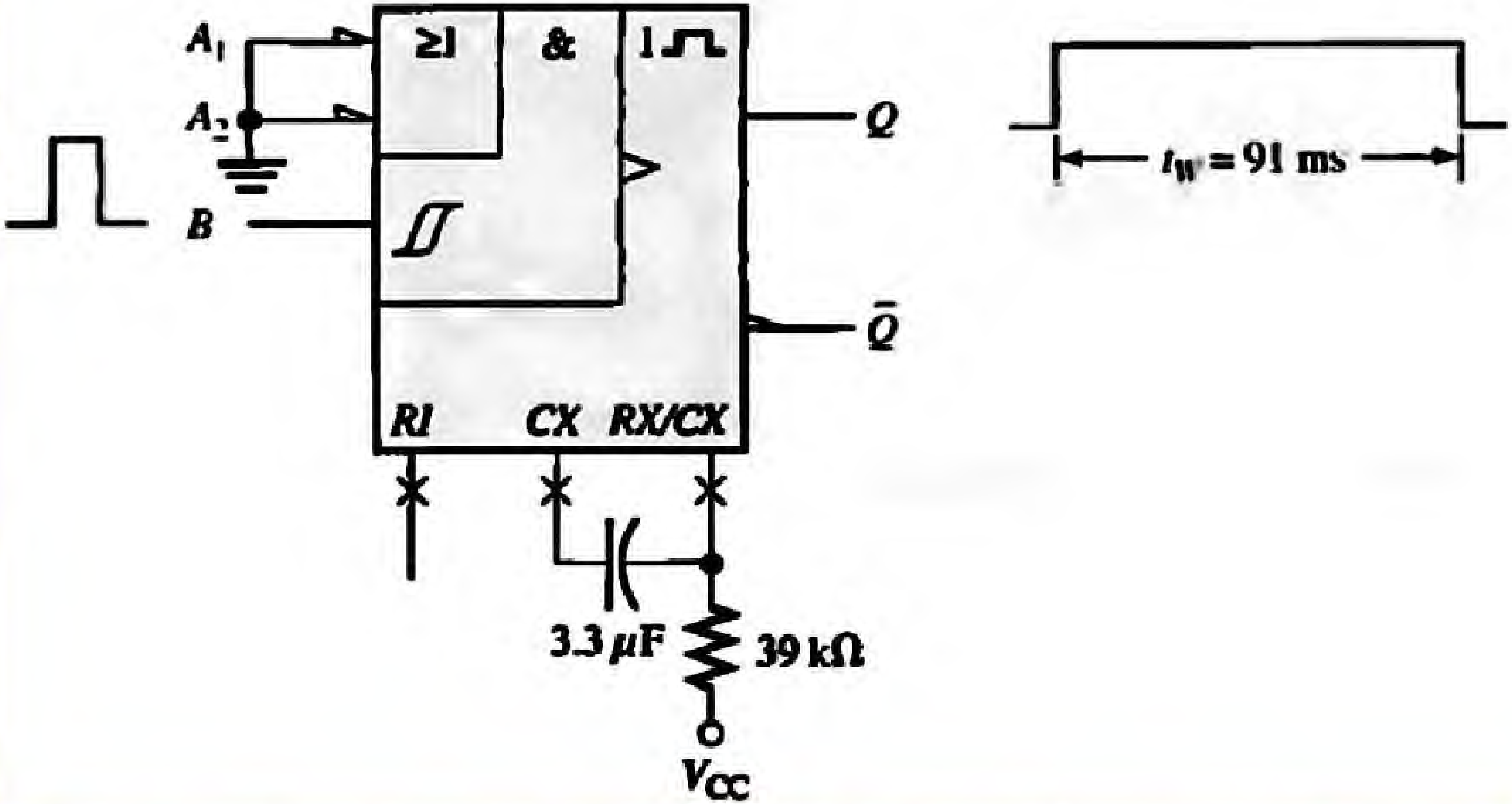



**Figure (1.31)**

- ✓ **To achieve a pulse width closer to 100 ms, other combinations of values for $R_{EXT}$ and $C_{EXT}$ can be tried.**
- ✓ **For example, $R_{EXT}$ = 68 kΩ and $C_{EXT}$ = 2.2 μF gives a pulse width of 105 ms.**

**Example 1:12** **Determine the values of $R_{EXT}$ and $C_{EXT}$ that will produce a pulse width of 1 μs when connected to a 74LS122.**

**Solution:**

- ✓ **Assume a value of $C_{EXT}$ = 560 pF and then solve for $R_{EXT}$.**

$$\mathbf{t_W = 0.32 \times R_{EXT} \times C_{EXT}\left(1 + \frac{0.7}{R_{EXT}}\right)}$$

$$\mathbf{t_W = 0.32 \times R_{EXT} \times C_{EXT} + 0.32 \times C_{EXT} \times 0.7}$$

$$\mathbf{R_{EXT} = \frac{t_W - 0.32 \times 0.7 \times C_{EXT}}{0.32 \times C_{EXT}}}$$

$$\mathbf{R_{EXT} = \frac{t_W}{0.32 \times C_{EXT}} - 0.7}$$

$$\mathbf{R_{EXT} = \frac{10^{-6}}{0.32 \times 560 \times 10^{-12}} - 0.7 = 5.58\,k\Omega}$$

## 1.12.5-An Application.

- ✓ One practical one-shot application is a sequential timer that can be used to illuminate a series of lights.
- ✓ This type of circuit can be used, for example, in a lane change directional indicator for highway construction projects or in sequential turn signals on automobiles.
- ✓ Figure (1.32) shows three 74LS122 one-shots connected as a sequential timer. This particular circuit produces a sequence of three 1s pulses.

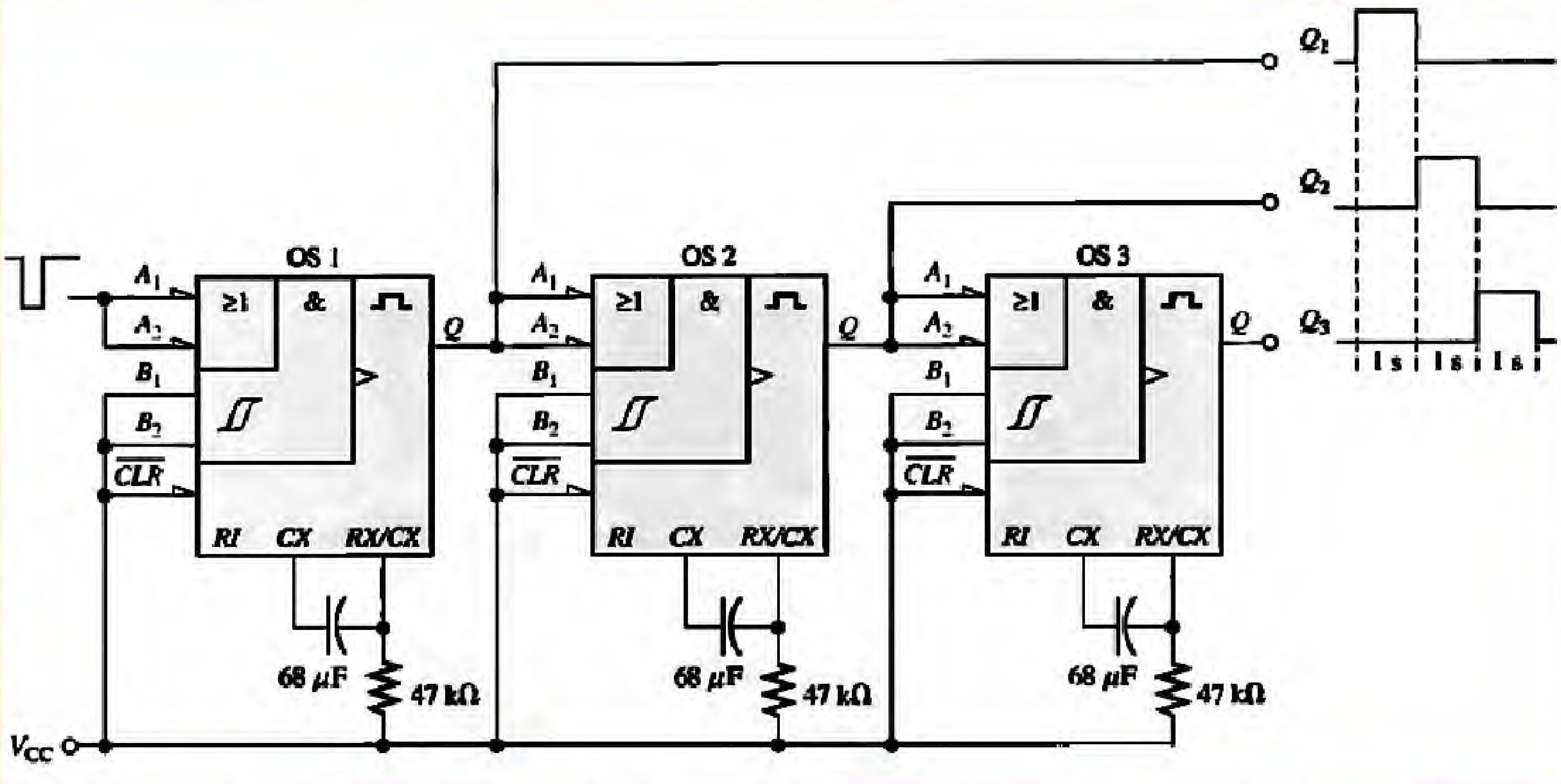



Figure (1.32) A sequential timing circuit using three 74LS122 one-shots.

- ✓ The first one-shot is triggered by a switch closure or a low-frequency pulse input, producing a 1s output pulse.
- ✓ When the first one-shot (OS1) times out and the 1s pulse goes LOW, the second one shot (OS2) is triggered, also producing a 1s output pulse.
- ✓ When this second pulse goes LOW, the third one-shot (OS3) is triggered and the third 1s pulse is produced.
- ✓ The output timing is illustrated in the figure. Variations of this basic arrangement can be used to produce a variety of timed outputs.